RADIATION PHYSICS NOTE #11

ENCLOSURE 100 LABYRINTH STUDIES

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On 10/26/76 a series of measurements was made in the
E100 labyrinth at the emergency exit with the recombination
chamber. The reason for making the measurements at this time
was that E344 had a 12" long 4" diameter Cu target inside
3BØØT(a 10' long EPB dipole). This target was inside the aperture
of the emergency exit, hence conditions were similar to those of
E211 (Radiation Physics Note #9). The intensity in the pings
was approximately 2.2×10^{11} and hence the effect from this target
was expected to be much greater than the background from the muon
line operation. We shall present three results:

1. An absolute calcuation of the neutron flux and a
comparison to the recombination chamber response at
the door of E100.

2. A comparison of the fall off in the labyrinth of
the chamber response to the expected fall off using
the parameters in RP #9.

3. Quality factor measurements at three locations inside
the labyrinth.

In order to make the absolute calculation we shall follow the
similar calculation in RP #9.

 Figure 1 depicts the geometry of the problem. As in RP #9
we measure longitudinal distances in units of 56" (this is the

square root of the area of the tunnel). From the figure we see
that the two distances of interest are

$$d1 = \text{target to labyrinth entrance} = 9'$$

$$d2 = \text{distance from entrance to exit door} = 9.2 \text{ units}$$

$$(43')$$

Following the reasoning in RP #9 and assuming 1 neutron/GeV
isotropically distributed, we can estimate n/cm^2 at the labyrinth
mouth in the following manner:

$$\text{Neutron Flux} = \frac{N * E}{4\pi r^2} = \frac{2.2 \times 10^{11} \ 400}{4\pi \ (9 \times 12 \times 2.54)^2} = 9.3 \times 10^7 \ n/cm^2 \text{ pulse.}$$

$$N = \text{number of incident protons} = 2.2 \times 10^{11}$$

$$E = \text{incident energy in GeV} = 400 \text{ GeV}$$

$$r = \text{source to labyrinth mouth distance}$$

Now we will use the exponential fit for the first leg as
given in RP #9 and calculate the attenuation to the exit door.

Attenuation factor $= .745 \ e^{-.98 * 9.2} = 9 \times 10^{-5}$.

Hence at the door we expect $n/cm^2 = 8.4 \times 10^3 \ n/cm^2$ pulse.

Using the quoted sensitivity of the chamber we measure 1.5 mrad/
pulse at the exit door, and we wish to relate this to n/cm^2. As
discussed below we have measured the quality factor at the door to
be 6.5. If we make the rash assumption that all the neutrons are
10 MeV (QF = 6.5), then from p. 69 of Patterson and Thomas we find
that $3600 n/cm^2 = 1$ mrad, and hence we would expect $1.5 \times 3600 \ n/cm^2 =$
$5.4 \times 10^3 \ n/cm^2$ at the door, to be compared to the calculated value
of $8.4 \times 10^3 \ n/cm^2$. These two values are reasonably close given
the nature of the assumptions made.

Next we shall compare the attenuation of the chamber response in the labyrinth to the parametrized fall off in the E211 data. Since the detectors are not the same, precise agreement would be surprising.

There are three attenuation factors in the comparison of the first to the second chamber measurement. The second measurement was made

A	14' further down leg #1
B	around the bend
C	3' further into leg #2.

Hence we have an overall attenuation factor of

$$(e^{-.98 * 3.}) \left(\frac{1}{3}\right) (e^{-1.05 * .64}) = .009$$

and we have measured a value of .006. The value of 3 instead of 5 for the attenuation due to the bend is due to the fact that there is no cul-de-sac. The next measurement was made 10' 8" further down leg #2 and again around the corner. Here the bend factor was assumed to be 2.5 instead of 4 (the reduction of the attenuation for bends one and two was the same). The measured and calculated attenuation factors are both .06.

The quality factor was measured at the three chamber positions, and the results are summarized in this table

position	QF
1	6.5
2	2.8
3	2.0

The second digit is illusory since the errors are on the order of 30%. However, fig. 2 shows the data from this set of measurements along with results for a Cesium source, a PuBe source, and for 225 GeV/c muons. The data is plotted in the following manner, for each voltage setting the current is divided by the current at a voltage of 1200 volts. Hence, all the curves start at a value of $I/I_{sat} = 1$. Qualitatively the data from the position near the door follow the PuBe data quite well, and the data from position number 2 clearly falls between the Cesuim source (QF = 1.) and the PuBe source QF (measured to be 6.8).

The formula for computing quality factors from recombination chamber measurements is QF = 25* $(1. - I_{V=65}/I_{V=1200})$, and the quoted errors are ± 25%. This is how the values quoted above were obtained. However, to have confidence in the result, a complete plateau curve should be taken. Using the curves taken at positions 1 and 2 it is clear that there is a real change in the chamber response as a function of applied voltage, confirming that there is a real change in QF.
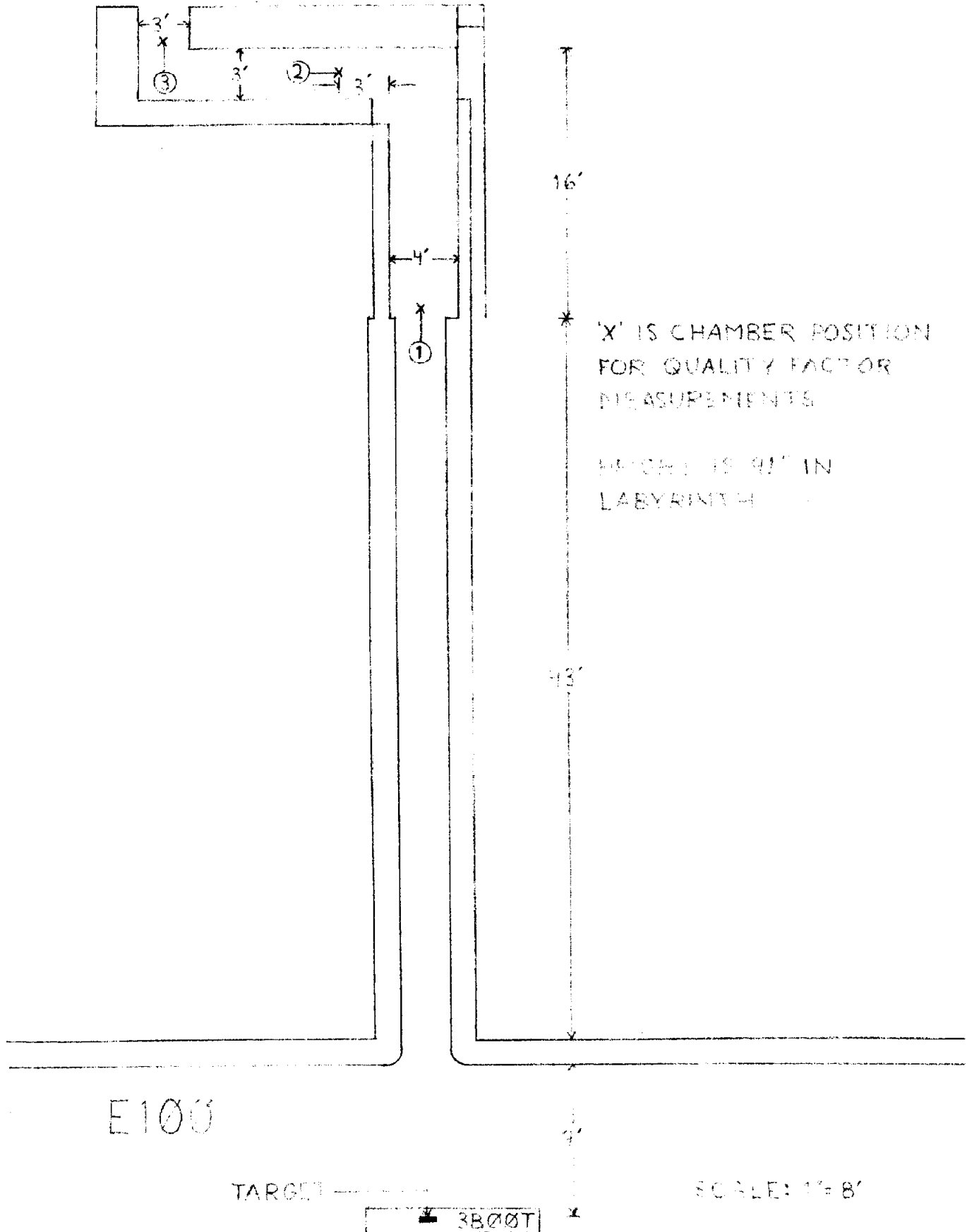
SUBJECT

FIGURE 1 E100 LABYRINTH

NAME

DATE   **REVISION DATE**

'X' IS CHAMBER POSITION
FOR QUALITY FACTOR
MEASUREMENTS

HEIGHT IS 9' IN
LABYRINTH

E100

TARGET

3B00T

SCALE: 1'= 8'

Figure 2

X PuBe · Cs ○ MUON + E100 (100+) (POSITION #1)
□ B100 (2nd les) (POSITION #2)
δ / / V / / /